AGENDA

- **Bob Curtis**, Almond Board of California, moderator
- **David Haviland**, UCCE, Kern County
- **Jhalendra Rijal**, UCCE, IPM Advisor
- **Emily Symmes**, UCCE, IPM Advisor
INSECT MANAGEMENT SESSION

Emily Symmes
David Haviland
Jhalendra Rijal

University of California Cooperative Extension
and UC Statewide IPM Program
Navel Orangeworm
- Sanitation
- Insecticides
- Mating disruption

Spider Mites
- Use of thresholds
- Biological control

Brown Marmorated Stink Bug
NOW in 2017 – Sanitation Issues
NOW in 2017 – Sanitation Issues
Sanitation

Minimize damage from other sources

Timely harvest

Insecticides
Build your foundation...

SANITATION!!!

No amount of sprays can make up for a shaky foundation
1. Direct reduction of overwintering populations

2. Minimize oviposition and development sites of early generations
### Sanitation Research & Guidelines

#### TABLE 2. Relationship between average numbers of tree and ground mummies per tree and ‘Nonpareil’ kernel damage by navel orangeworm, 2003–2006

<table>
<thead>
<tr>
<th>Tree mummies</th>
<th>Damage</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>avg. no./tree</td>
<td>%</td>
<td>no.</td>
</tr>
<tr>
<td>0</td>
<td>1.63</td>
<td>605</td>
</tr>
<tr>
<td>0.01–0.49</td>
<td>1.22</td>
<td>1,092</td>
</tr>
<tr>
<td>0.5–0.69</td>
<td>1.57</td>
<td>91</td>
</tr>
<tr>
<td>0.7–0.79</td>
<td>2.32</td>
<td>39</td>
</tr>
<tr>
<td>0.8–1.75</td>
<td>3.53</td>
<td>61</td>
</tr>
<tr>
<td>≥ 1.76</td>
<td>7.85</td>
<td>44</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ground mummies</th>
<th>Damage</th>
<th>Sections</th>
</tr>
</thead>
<tbody>
<tr>
<td>avg. no./tree</td>
<td>%</td>
<td>no.</td>
</tr>
<tr>
<td>0–4.9</td>
<td>1.39</td>
<td>1,272</td>
</tr>
<tr>
<td>4.91–7.9</td>
<td>1.57</td>
<td>300</td>
</tr>
<tr>
<td>7.91–8.9</td>
<td>1.72</td>
<td>67</td>
</tr>
<tr>
<td>8.91–9.0</td>
<td>2.78</td>
<td>44</td>
</tr>
<tr>
<td>≥ 9.1</td>
<td>2.72</td>
<td>238</td>
</tr>
</tbody>
</table>

### Sanitation Thresholds*

<table>
<thead>
<tr>
<th>Southern &amp; Central SJV</th>
<th>Northern SJV &amp; SV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 0.2 mummies/tree AND 8/tree on ground</td>
<td>Average 2 mummies/tree</td>
</tr>
</tbody>
</table>

UC IPM Pest Management Guidelines 2017

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*Higbee & Siegel, Cal Ag 2009*
### NOW Predictor

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Previous NOW Damage</td>
<td>1.5%</td>
<td>1.5%; (Range 0 - 19.0%)</td>
<td></td>
</tr>
<tr>
<td>PTB Damage</td>
<td>0.3%</td>
<td>0.3%; (Range 0 - 9.2%)</td>
<td></td>
</tr>
<tr>
<td>Ground Mummies per Tree</td>
<td>4.9</td>
<td>4.9; (Range 0 - 43.7)</td>
<td></td>
</tr>
<tr>
<td>Tree Mummies per Tree</td>
<td>1.0</td>
<td>1.0; (Range 0 - 69.7)</td>
<td></td>
</tr>
<tr>
<td>Standardized Harvest Percentile</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choose a value from below**

- 0 - 2.5% = -2.6
- 2.6% - 25% = -0.6
- 50% = 0
- 51 - 75% = 0.7
- 76 - 97.5% = 1.8
- 98 - 100% = 2.6

**Distance from Center to Nearest Pistachios**

- 8,656

**Predicted Damage**

- 1.86%

*Based on sample data; the average damage in Kern County was 1.77% based on 1,279 40-acre plots in 2004 - 2006.*
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Previous NOW Damage</td>
<td>3.0%</td>
<td>Mean = 1.5%; (Range 0 - 19.0%)</td>
</tr>
<tr>
<td>PTB Damage</td>
<td>0.0%</td>
<td>Mean = 0.3%; (Range 0 - 9.2%)</td>
</tr>
<tr>
<td>Ground Mummies per Tree</td>
<td>15</td>
<td>Mean = 4.9; (Range 0 - 43.7)</td>
</tr>
<tr>
<td>Tree Mummies per Tree</td>
<td>3.0</td>
<td>Mean = 1.0; (Range 0 - 69.7)</td>
</tr>
<tr>
<td>Standardized Harvest Percentile</td>
<td>0.7</td>
<td></td>
</tr>
</tbody>
</table>

Choose a value from below**

- 0 - 2.5% = -2.6
- 2.6% - 25% = -0.6
- 50% = 0
- 51 - 75% = 0.7
- 76 - 97.5% = 1.8
- 98 - 100% = 2.6

Distance from Center to Nearest Pistachios | 5,000 | Mean = 8,656; (Range 550 - 12,000)***

Predicted Damage                          | 3.39% | Based on sample data; the average damage in Kern County was 1.77% based on 1,279 40-acre plots in 2004 - 2006.
CURRENT MANAGEMENT OPTIONS

• Winter sanitation
  – 0.5-2 Mummies per tree
• Early/Timely harvest
• Insecticides
  – 1-2 insecticide sprays
  – Intrepid, Altacor, pyrethroids
  – Resistance to pyrethroids
  – No new products coming down the pipe
• Mating Disruption
MATING DISRUPTION

• Use synthetically-produced pheromone to disrupt mating
• Pheromone is placed in aerosol cans inside cabinets
• Dispensers emit female pheromone when mating occurs
• Males struggle to find females
• Mating is delayed or reduced
• Egg deposition reduced
NOW Mating Disruption History

1980’s
Trap suppression documented by Landolt, Curtis et al.

1990’s
Shorey showed trap shut-down with puffers in 40 ac perimeters

2002-2007
Higbee and Burks demonstrated impact on damage reduction in 20 and 40 ac almond plots
Puffers in grids most effective

2005
Commercial product available

2008-2012
USDA NOW Areawide Project showed value of NOW mating disruption on commercial scale with, or in place of, traditional insecticides
PRODUCT COMPARISONS

Puffer NOW
(Suterra)

Isomate NOW
(Pacific Biocontrol)

Cidetrak NOW?
(Trécé)
(Not Registered)

Semios NOW
(Semios)
<table>
<thead>
<tr>
<th></th>
<th>Puffer NOW (Suterra)</th>
<th>Semios NOW (Semios)</th>
<th>Isomate NOW (Pacific Biocontrol)</th>
<th>Cidetrak NOW? (Trécé)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered</td>
<td>2006</td>
<td>2016</td>
<td>2017</td>
<td>Not Registered</td>
</tr>
<tr>
<td>Type</td>
<td>Aerosolized canister</td>
<td>Aerosolized canister</td>
<td>Aerosolized canister</td>
<td>Passive dispenser</td>
</tr>
<tr>
<td>Density per acre</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Release rate</td>
<td>Static</td>
<td>Variable</td>
<td>Static</td>
<td>Static</td>
</tr>
<tr>
<td>Installation</td>
<td>Grower-supplied</td>
<td>Provided</td>
<td>Grower-supplied</td>
<td>Grower-supplied</td>
</tr>
<tr>
<td>Organic</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Add-ons</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Price</td>
<td>Approx. $110-$120/acre</td>
<td></td>
<td>Semios has additional costs for add-ons</td>
<td></td>
</tr>
</tbody>
</table>

*1 weather station, pheromone-based camera traps, temp/humidity sensors in all cabinets, alternaria model, NOW degree-day models, chill monitoring, irrigation monitoring, login-based computer interface
DESIGN

• 4 Treatments plus Check
• 40-acre plots (4,000 trees)
• Replicated in 3 orchards
• Entire orchards treated with 1-2 insecticides at hull split
• Weekly NOW trap counts
• 4 harvest samples at the core of each plot for each variety
PHEROMONE TRAP CAPTURES

WASCO

<table>
<thead>
<tr>
<th></th>
<th>Cum. Apr-Sept</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Su</td>
<td>28</td>
<td>91</td>
</tr>
<tr>
<td>PB</td>
<td>54</td>
<td>82</td>
</tr>
<tr>
<td>Se</td>
<td>20</td>
<td>93</td>
</tr>
<tr>
<td>Tr</td>
<td>31</td>
<td>89</td>
</tr>
<tr>
<td>Avg</td>
<td></td>
<td>89%</td>
</tr>
</tbody>
</table>

- Control
- Suterra
- Pac. Bio.
- Semios
- Trece
PHEROMONE TRAP CAPTURES
MARICOPA

<table>
<thead>
<tr>
<th></th>
<th>Cum. Apr-Sept</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>645</td>
<td></td>
</tr>
<tr>
<td>Su</td>
<td>54</td>
<td>92</td>
</tr>
<tr>
<td>PB</td>
<td>17</td>
<td>97</td>
</tr>
<tr>
<td>Se</td>
<td>32</td>
<td>95</td>
</tr>
<tr>
<td>Tr</td>
<td>26</td>
<td>96</td>
</tr>
<tr>
<td>Avg.</td>
<td></td>
<td>95%</td>
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</table>
PHEROMONE TRAP CAPTURES
BUTTONWILLOW

<table>
<thead>
<tr>
<th></th>
<th>Cum. Apr-Sept</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>133</td>
<td></td>
</tr>
<tr>
<td>Su</td>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>PB</td>
<td>11</td>
<td>92</td>
</tr>
<tr>
<td>Se</td>
<td>24</td>
<td>82</td>
</tr>
<tr>
<td>Tr</td>
<td>10</td>
<td>93</td>
</tr>
<tr>
<td>Avg</td>
<td></td>
<td>91%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>NOW Males/trap/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-Mar</td>
<td>1</td>
</tr>
<tr>
<td>20-Apr</td>
<td>1</td>
</tr>
<tr>
<td>20-May</td>
<td>1</td>
</tr>
<tr>
<td>20-Jun</td>
<td>1</td>
</tr>
<tr>
<td>20-Jul</td>
<td>1</td>
</tr>
<tr>
<td>20-Aug</td>
<td>1</td>
</tr>
<tr>
<td>20-Sep</td>
<td>1</td>
</tr>
<tr>
<td>20-Oct</td>
<td>1</td>
</tr>
</tbody>
</table>

Legend:
- Control
- Suterra
- Pac. Bio.
- Semios
- Trece
HARVEST

Damage Reductions

Wasco 62%
Maricopa 45%
Buttonwillow 20%
Average 46%
Economics

• Assumptions
  – 3000 lb/ac for each variety
  – 50% NP, 25% Mont. 25% Fritz
  – $2.50/lb for NP, $2.25 for pollinizers
  – $0.0 to $0.16 premium sliding scale for low Nonpareil damage based on Blue Diamond Crop Quality Schedule
  – $0.0 to $0.09 premium for pollinators
  – Premiums for in-shell nuts are not included
  – Assume half of damaged kernels blown out at harvest or removed through the shelling process

<table>
<thead>
<tr>
<th></th>
<th>Per/acre returns</th>
<th>$ difference/ac</th>
</tr>
</thead>
<tbody>
<tr>
<td>No MD</td>
<td>$7,275</td>
<td></td>
</tr>
<tr>
<td>Suterra</td>
<td>$7,400</td>
<td>+$125</td>
</tr>
<tr>
<td>Semios</td>
<td>$7,385</td>
<td>+$110</td>
</tr>
<tr>
<td>Pac. Bio.</td>
<td>$7,385</td>
<td>+$110</td>
</tr>
<tr>
<td>Trécé</td>
<td>$7,381</td>
<td>+$106</td>
</tr>
</tbody>
</table>
PEST MANAGEMENT ALLIANCE GRANT

- Demonstration project
- Funded by DPR
- Partnership between DPR, UC, Almond Board, Growers, PCAs
- Side by side comparisons
- Objective is to improve IPM
- NOW goal- demonstrate MD
  - In addition to a spray program
  - Or in exchange for a spray program
- Spider mites- demonstrate threshold-based decision-making
  - Impacts on biocontrol
  - Documentation of role of sixspotted thrips in biocontrol
  - Demonstrate ability to reduce miticide use
DEMONSTRATION PLOTS - WASCO

• Conventional Program
  - Hull split spray $60
  - Post-hull split spray $60

• PMA Program
  - Mating disruption $120

• Results
  - Low NOW pressure
  - 97.2% reduction in moth captures
  - 73% reduction in damage
  - $33.50 increase in crop value
  - Spray and MD costs offset
  - $33.50 increase in profit
DEMONSTRATION PLOTS- MARICOPA

- Conventional Program
  - Hull split spray $60
- PMA Program
  - Hull split spray $60
  - Mating disruption $120
- Results
  - Moderate NOW pressure
  - 92.7% reduction in moth captures
  - 5% reduction in damage
  - $39.22 increase in crop value
  - $120 cost for MD
  - $80.78 net loss
DEMONSTRATION PLOTS- BUTTONWILLOW

- Conventional Program
  - Hull split spray $60

- PMA Program
  - Hull split spray $60
  - Mating disruption $120

- Results
  - Moderate NOW pressure
  - 94.2% reduction in moth captures
  - 79% reduction in damage
  - $363.81 increase in crop value
  - $120 cost for MD
  - $243.81 net benefit
Economic and other values for MD

- Increases in crop value *(Avg. $143) offset costs for MD (Appx. $120)
- Reduction of aflatoxins
- Value of being ‘sustainable’ when marketing
- Reduced risk of NOW resistance to limited insecticide tools (Intrepid, Altacor, pyrethroids)
- Benefit likely increased in larger plots
- Year over year benefit (post-harvest mating disruption)
- Setup and takedown occur when labor is available
- No treatment timings, PHIs, REIs or residues
- Cost-benefit ratios would be higher in higher-pressure orchard situations
MAXIMIZING BIOLOGICAL CONTROL
FOR SPIDER MITES IN ALMONDS
## IPM IN ALMONDS

<table>
<thead>
<tr>
<th>Pest</th>
<th>15 years ago</th>
<th>current</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navel orangeworm</td>
<td>Azinphos-methyl</td>
<td>Methoxyfenozide, Chlorantraniliprole</td>
</tr>
<tr>
<td>San Jose scale</td>
<td>Methamidiphos, other OPs</td>
<td>Aphytis, Encarsia, IGRs</td>
</tr>
<tr>
<td>Fire ants</td>
<td>Chlorpyrifos</td>
<td>Ant baits</td>
</tr>
<tr>
<td>Leaffooted bug</td>
<td>Chlorpyrifos, bifenthrin</td>
<td>Abamectin</td>
</tr>
<tr>
<td>Peach twig borer</td>
<td>Pyrethroids, OPs, Oil</td>
<td>Biocontrol, various</td>
</tr>
<tr>
<td>Spider mites</td>
<td>Propargite</td>
<td>Many options</td>
</tr>
</tbody>
</table>
SPIDER MITE BIOCONTROL - SIXSPOTTED THRIPS

- Entire life cycle passed on the host
- Facultatively arrhenotokous
  - Mating, but if not mated males only
- Food- almost exclusively spider mites
  - 49.7 (86°F) to 20.7 (68°F) mite eggs per day
  - Also eat other stages of mites
  - Cannibalistic if food is scarce
- Population doubling time
  - 8.7 (68°F) to 2.7 (86°F) days
- Thigmotaxis evident on all stages
  - They love to get inside of webbing

Gilstrap and Oatman, 1976; Coville and Allen, 1977
- Evaluated 7 card types at two locations
- Cut them all to the same size
- Averaged 3 to 475 thrips/week
- Yellow strip, small yellow and green cards caught the most
- Green is hard to use
- Yellow strip is the cheapest
MONITORING- CARD SIZE RESULTS

- For trials we now use yellow strip traps
- 3” x 5”
- Case of 1000 for $260
- Great Lakes IPM
- Hang from tree using binder clop and large uncoiled paper clip
SIXSPOTTED THRIPS ACTIVE MID-APRIL TO MID-MAY

- Traditional ‘preventative’ spray timing
- Miticides should never be used in May without monitoring for spider mites and thrips
- Don’t starve sixspotted thrips
- If thrips are present, avoid use of pyrethroids and abamectin
MITE BIOCONTROL

- Sixspotted thrips present in all three locations
- Approximate 2-week delay between exponential mite increases and exponential thrips response
- Sixspotted thrips populations doubled every 2.4, 2.7, and 3.6 days (Avg. 2.9)
- Predatory beetles present at all sites
- Using thresholds and thrips we reduced mite sprays by 1-2 per season
<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Pacific Spider Mite</th>
<th>Sixspotted thrips</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>Shafter</td>
<td>15.9</td>
<td>4.2</td>
</tr>
<tr>
<td>2016</td>
<td>McFarland</td>
<td>6.0</td>
<td>4.2</td>
</tr>
<tr>
<td>2017</td>
<td>Shafter</td>
<td>3.8</td>
<td>2.3</td>
</tr>
<tr>
<td>2017</td>
<td>Maricopa</td>
<td>9.3</td>
<td>2.7</td>
</tr>
<tr>
<td>2007</td>
<td>Buttonwillow</td>
<td>3.0</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td><strong>Average</strong></td>
<td><strong>7.6</strong></td>
<td><strong>3.4</strong></td>
</tr>
</tbody>
</table>
CONCLUSIONS

- Sixspotted thrips is a formidable predator
- Don’t treat for mites without monitoring mites and sixspotted thrips
- Can be monitored with sticky cards
- Shows up naturally, highly mobile
- Excellent population doubling times
- Excellent predator characteristics
  - Thigmotactic, high preference for spider mites, cannibalistic when food is scarce
- Don’t starve them, use thresholds
- Don’t kill them with insecticides
THIS RESEARCH WAS FUNDED BY THE
ALMOND BOARD OF CALIFORNIA
CA DEPT. OF PESTICIDE REGULATION
WITH IN-KIND CONTRIBUTIONS FROM SUTERRA,
SEMIOS, PACIFIC BIOCONTROL, AND TRÉCÉ

Thank you
Grower and PCA Cooperators
Field assistance- Stephanie Rill, Dan Rivers,
Chelsea Gordon, Joseph Aguilar, Laurren
Heppner, Mackenzie Zeimet, Eryn McKinney,
Daniel Green and Emily Buerer
NAVEL ORANGEWORM AND MITES: NORTHERN SAN JOAQUIN VALLEY PERSPECTIVE

Jhalendra Rijal
IPM Farm Advisor, Northern SJV
UC Cooperative Extension- Stanislaus, Modesto, CA
1. Navel orangeworm
2. Spider mites
3. Leaffooted bug
4. Ant
5. Peach twig borer
6. San Jose scale

PMA project sites

(Northern San Joaquin Valley)
**Ballico site, Merced Co.**

Variety: NP/Monterey/Fritz  
Age: 5\textsuperscript{th} leaf

<table>
<thead>
<tr>
<th>Practice</th>
<th>Conv.</th>
<th>IPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter sanitation</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>NOW mating disruption</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>May worm spray</td>
<td>Yes (pyrethroid)</td>
<td>No</td>
</tr>
<tr>
<td>May mite spray (Abamectin)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hull-split worm (Intrepid)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hull-split mite (Fujimite)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Practice Conv. IPM**  
**Conventional, 120 ac.**  
**IPM, 73 ac.**
Average spider mite and six-spotted thrips population (no./leaf) in Ballico site.

- **Conv mites**
- **IPM mites**
- **Conv thrips**
- **IPM thrips**
Ballico site, Navel Orangeworm

% NOW Damage-Ballico Site

- Nonpareil
- Monterey
- Fritz

Categories:
- No MD
- Mating disruption
**Turlock site, Stanislaus Co.**

Variety: NP/Carmel/Monterey  
Age: 10-12th leaf

<table>
<thead>
<tr>
<th>Practice</th>
<th>Conv.</th>
<th>IPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter sanitation</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>NOW mating disruption</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>May worm spray (Abamectin)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>May mite spray (Abamectin)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>June LFB spray</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hull-split worm (Intrepid)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hull-split mite</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Conventional 38 ac.**

**IPM 40 ac.**
Turlock site, Spider mites

Average spider mite and six-spotted thrips population (no./leaf) in Turlock site

Conv mites  IPM mites
Conv thrips  IPM thrips


Mites/leaf

Thrips/leaf

0.0 0.05 0.1 0.15 0.2 0.25

0.0 2.0 4.0 6.0 8.0 10.0

Average spider mite and six-spotted thrips population (no./leaf) in Turlock site

Conv mites  IPM mites
Conv thrips  IPM thrips


Mites/leaf

Thrips/leaf

0.0 0.05 0.1 0.15 0.2 0.25

0.0 2.0 4.0 6.0 8.0 10.0
Turlock site, Navel Orangworm

% NOW Damage-Turlock Site

Overall damage reduction = 57.3%

- Nonpareil: Damage reduction = 64%
- Carmel: Damage reduction = 20%
- Monterey: Damage reduction = 88%
**Escalon site, San Joaquin Co.**

Variety: NP/Aldrich/Woodcolony
Age: 4th leaf

<table>
<thead>
<tr>
<th>Practice</th>
<th>Conv</th>
<th>IPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter sanitation</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NOW mating disruption</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>May worm/mite spray</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Hull-split worm spray</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hull-split mite (Abamectin)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Conventional, 70 ac.
IPM, 60 ac.
Escalon site, Navel Orangeworm

% NOW Damage-Escalon Site

Overall damage reduction = 70%

Nonpareil: Damage reduction = 80%
Aldrich: Damage reduction = 72%
W. colony: Damage reduction = 57%
CONSIDERATIONS WHILE USING MATING DISRUPTION

• Area/block size under mating disruption

CONSIDERATIONS WHILE USING MATING DISRUPTION

• Topography of the land
CONSIDERATIONS WHILE USING MATING DISRUPTION

- Wind direction/edge effect

Source: Suterra.com
Escalon site

Conventional site:
Avg % damage (edge)= 5.5
Avg % damage (center)= 6.6

IPM site:
Avg % damage (edge)= 3.8
Avg % damage (center)= 1.3
Conventional site:
Avg % damage (edge)= 1.35
Avg % damage (center)= 1.40

IPM site:
Avg % damage (edge)= 1.1
Avg % damage (center)= 0.5
Navel orangeworm (NOW) egg trap and degree days (Modesto area) (avg. of total 12 traps in 3 orchards)

Egg biofix: 19 April 100 DD:
2 May
1200 DD: 8 July
Conclusion: IPM Approach for mite and NOW management

1. Mites:
   - Monitor mites and predator population
   - Threshold-based treatment
   - Avoid broad-spectrum insecticides and prophylactic miticide application

2. Navel orangeworm
   - Monitoring/DD (egg traps, adult traps)
   - Winter sanitation
   - Use of mating disruption (an excellent candidate for IPM)
   - Insecticide (based on DD and crop phenology)
   - Synergy between insecticide and mating disruption
     - Reducing high pest pressure
     - Targeted application in the orchard such as edge, bottom of the hills etc.
NEW PEST UPDATE:
BROWN MARMORATED STINK BUG (BMSB)

Jhalendra Rijal
IPM Farm Advisor, Northern SJV
UC Cooperative Extension-
Stanislaus, Modesto, CA
BROWN MARMORATED STINK BUG

- Invasive stink bug, *Halyomorpha halys* (Stal)
- First detection in PA around late-1990s
- In 2010, significant economic loss in Mid-Atlantic States ( $37 million only in apple)

Photo: Doug Pfeiffer, Virginia Tech

~5/8 inch long, marble brown

www.pestworld.org
BMSB DISTRIBUTION IN THE US: 43 STATES

Established in 9 Counties

Detected in >19 Counties
HOW DIFFERENT BMSB FROM OTHER STINK BUGS

Rough Stink Bug, *Brochymena quadripustulata*

Conspere Stink Bug *Euschistus conspersus*

Brown Marmorated Stink Bug *Halyomorpha halys*

http://www.stopbmsb.org/stink-bug-basics/look-alike-insects/
LIFE STAGES OF BMSB

Eggs/1st instar nymphs
**SEASONAL PHENOLOGY**


- **Winter/late Fall**
  - Disperse from overwintering sites to early season hosts
  - Seek out and settle in overwintering sites
  - Continue to feed on fruiting crops as they mature
  - Infest late season hosts before overwintering

---

2015-BMSB IN MODESTO (NEAR HIGHWAY-99)
2016-BMSB FINDING IN A PEACH ORCHARD

Seasonal total BMSB adults/4 traps (July-Oct)

- Trece: 23
- Alpha Scents: 7

Location:
- Almonds
- Walnuts
- Cherries
- Peaches
2017 BMSB MONITORING

Pyramid Trap

4 ft tall

Trécé dual lure (murgantiol & MDT)

• 4 Pyramid traps
• 4 Sticky panel traps

Sticky Panel Trap

4 ft tall

Photo: T. Leskey
2017-BMSB TRAPPING IN PEACH ORCHARD

Weekly BMSB adults/4 traps

- Pyramid
- Sticky Panel

0 1 2 3 4

Avg. weekly BMSB adults per trap (pyramid trap)

- **Adult**
- **Nymph**

**BMSB PHENOLOGY IN MODESTO AREA (2017-NSJV)**
2017-BMSB TRAPPING IN ALMOND ORCHARD

Weekly BMSB adults/4 traps

- Pyramid
- Sticky Panel
- Nymph (pyramid)
BMSB IN ALMONDS

(June-2017)
BMSB IN ALMONDS

- Excessive gumming, 2 orchards, maybe contributed by other bugs as well

<table>
<thead>
<tr>
<th>% gumming nuts (N = 16-92)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row 1</td>
</tr>
<tr>
<td>27.66</td>
</tr>
<tr>
<td>8.11</td>
</tr>
<tr>
<td>11.96</td>
</tr>
<tr>
<td>18.52</td>
</tr>
<tr>
<td>12.5</td>
</tr>
</tbody>
</table>

Gumming nuts: 8 – 58%
BMSB IN ALMONDS: JUNE FINDING

- Presence of necrotic spots (internally)
DAMAGE EVALUATION AT HARVEST
SIMILAR TYPE OF DAMAGE OBSERVED IN FEW OTHER ORCHARDS

We found

PCA found

Photo: T. Miller
CONCLUSION AND RECOMMENDATION FOR BMSB MONITORING

• BMSB spreading to agricultural areas
• BMSB can potentially cause damage to almonds
• Be vigilant about BMSB infestation in peach/almond orchards
• Conduct visual observation
• Inspect the fruits for damage (April-May)
• Use sticky panel traps with BMSB lure early in the season to detect BMSB presence in the orchard
ACKNOWLEDGEMENTS

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• Cooperator Growers,
• Pest Control Advisers
• Farm Advisors

Help from: Daniel Green, Daniel Rivers, Raquel Gomez, Emily Buerer,

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